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(54) Abstract Title

A method of detecting faults in an automated clutch

(57) An automated clutch is engaged/disengaged by a slave cylinder 36 operated by a master cylinder 32 which is actuated by an actuator 18 comprising an electric motor 20 driving worm gearing 22 and crank drive 24. A sensor 34 and a temperature sensor 33 detects a rotary position/speed and temperature of the electric motor 20. The electric motor 20 is supplied with a signal, eg a PWM signal, having a pulse width which is continuously measured by control unit 52 that also measures the position and/or speed of a component part, eg the master cylinder 32, operated by the electric motor 20. These measured values are compared with stored ideal values, in the control unit 52, and any deviation above a predetermined amount is regarded as a fault which is displayed by a fault indicator/display of the control unit 52 or by a diagnosis device connected to the control unit 52.

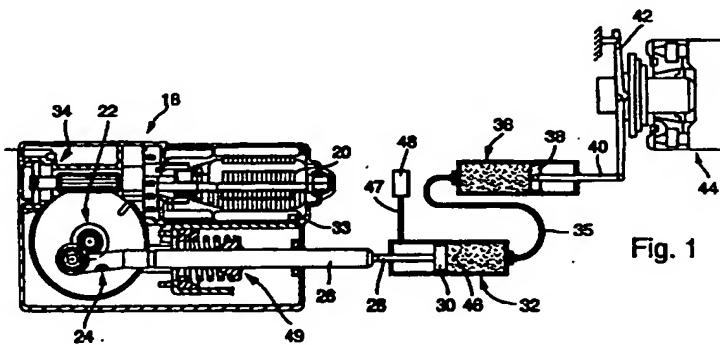


Fig. 1

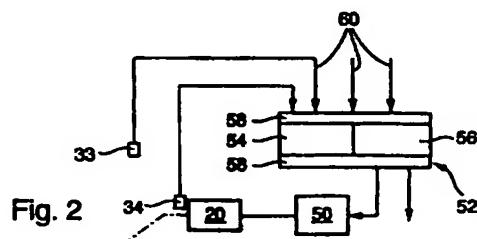


Fig. 2

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CLUTCH

The invention relates to a method for detecting faulty functions of a clutch operated by means of an actor, more 5 particularly an electric motor, more particularly in the drive train of a motor vehicle. The invention relates further to a device for carrying out the method.

Automated clutches have become increasingly significant in 10 recent times. In conjunction with manual shift transmissions or automatic shift transmissions such clutches lead to considerable improvement in operating comfort. In addition a reduction in fuel consumption is reached since owing to the lesser effort connected with a 15 gear change the vehicle is more often driven in the most favourable fuel-economy gear. In conjunction with automated manual shift transmission the comfort of conventional automatic gearboxes is achieved with these types of clutch without the improved comfort being linked 20 with an increase in fuel consumption which is generally the case with conventional automatic gearboxes with hydrodynamic torque converters.

Automated clutches have indeed reached a high state of 25 development and are extraordinarily reliable. However great significance is placed on a comfortable monitoring of their functional reliability in operation and with diagnosis in the case of customer service.

30 The invention seeks to provide a method for detecting faulty functions of a clutch operated by means of an actor, more particularly in the drive train of a motor vehicle by means of which faulty functions can be reliably detected without a great deal of additional expense. The 35 invention also seeks to provide apparatus for carrying out the method.

According to a first aspect of the invention, there is provided a method for detecting faulty functions of a clutch operated by means of a drive, more particularly in 5 the drive train of a motor vehicle wherein the drive is controlled by means of a control signal, in which method the pulse width of the control signal is detected or measured and the position and/or speed of a component part operated by the drive is determined.

10

According to a second aspect of the invention there is provided a method for detecting faulty functions of a clutch operated by means of a drive, more particularly in the drive train of a motor vehicle wherein the drive is 15 controlled by means of a control signal, with which method a value such as the pulse width of the control signal is detected or measured, the position and/or the speed of a component part operated by the drive is determined, the measured value, such as the pulse width and/or the 20 position and/or speed of the component part is compared with ideal values and when a deviation between the ideal values and measured values exceeds predetermined values a fault signal is produced.

25 By using a value such as the pulse width, and a geometric value of the component part moved by the electric motor for detecting faulty functions no additional sensors are required but the faulty functions can be detected by 30 purely software routines which are recorded in a control device for controlling the automated clutch or in the case of diagnosis are input in the control device from outside by means of a diagnosis appliance.

According to a third aspect of the invention there is 35 provided a method for detecting faulty functions of a clutch operated by means of an electric motor, more

particularly in the drive train of a motor vehicle wherein the electric motor is controlled by means of a PWM signal, with which method the pulse width of the PWM signal is measured, the position and/or speed of a component part 5 operated by the electric motor is determined, the measured pulse width and/or position and/or speed of the component part is compared with ideal values and in the event of a deviation between the ideal values and measured values which exceeds predetermined values a fault signal is 10 produced.

By using the pulse width and a geometric value of the component part moved by the electric motor to detect 15 faulty functions no additional sensors are required but faulty functions can be detected by purely software routines which are recorded in a control device for controlling the automated clutch or in the event of diagnosis are input in the control device from outside by means of a diagnosis appliance.

20

The method according to one of claims 1 to 3 is developed in a further advantageous manner through the features of claims 4 to 7.

25 With the method described above faulty functions can be diagnosed, such as overload of the electric motor as a result of heavy going in the transmission path from the electric motor to the clutch, a faulty clutch stop, a broken compensation spring etc.

30

Claim 8 characterises a second method for reaching the object of the invention. With this method for example a faulty stop can be recognised which can be due to different causes.

35

Claim 9 characterises a third embodiment of the method according to the invention with which for example an ideal value target can be automatically adapted.

5 With the features of claim 10 the accuracy and flexibility of the method according to the invention is improved.

Furthermore it is expedient if an ideal control signal preset and/or determined by a control unit is the detected 10 control signal.

Claim 12 characterises the basic structure of a device for carrying out the method according to the invention. The methods are thereby implemented in the device through 15 programming of the program memories which are known in micro processors.

The invention will now be explained in further detail by way of example and with reference to the accompanying 20 drawings in which:

Figure 1 is a diagram of a clutch operated by means of an actor;

25 Figure 2 is a block circuit diagram for controlling the actor of Figure 1;

Figure 3 shows a path sensor contained in the actor of Figure 1;

Figure 3a illustrates an actor with path sensor;

30 Figure 4 shows a circuit for controlling an electric motor contained in the actor of Figure 1;

Figure 5 shows characteristic lines of an electric motor contained in the actor of Figure 1;

Figure 6 is a diagram;

Figure 7 is a diagram and

35 Figure 8 is a block circuit diagram.

According to Figure 1 an actor such as an operating unit, marked overall by 18, contains an electric motor 20 which drives through a worm gearing 22 a crank drive 24 from which a linearly guided crank rod 26 projects which is 5 connected to a piston rod 28 which belongs to the piston 30 of a master cylinder 32. A temperature sensor 33 is provided for monitoring the temperature of the electric motor 20.

10 Instead of using the sensor 33, in another embodiment the temperature of the electric motor can be determined or calculated by the control unit of the automatically operable clutch by means of an implemented mathematical model wherein as input values for example individual 15 values of the following values can be used to calculate the temperature of the actor or electric motor: the electric currents, voltages and power outputs as well as the thermal currents, inputs and outputs and thermal capacities, as well as speeds and torques. By means of a 20 model which takes into account a thermal input, a storage of energy and an output of energy it is possible to calculate at any time the temperature of the actor or electric motor from a model.

25 The rotary position and/or speed of the electric motor 20 and thus the position/speed of the piston 30 is determined by means of at least one sensor 34 which is formed for example as an incremental sensor and in the event of rotation of the worm connected to the drive shaft of the 30 electric motor 20 about a predetermined angular amount sends out an impulse. The sensor can also be formed as an analogue sensor, such as for example an echo effect sensor, potentiometer, induction sensor, dip coil sensor or the like which supplies an analogue position signal 35 when the piston is displaced. Likewise an analogue-digital converter and/or microprocessor (ASIC) can be

connected in after the analogue sensor whereby these can also be formed as a structural unit. The sensor can thus also be formed as an absolute path sensor.

5 The master cylinder 32 is connected by a lead 35 to a slave cylinder 36 in which a piston 38 operates whose piston rod 40 operates the operating member 42 of a clutch 44. The clutch 44 is located in the drive train (not shown) of a motor vehicle between the drive motor and the
10 shift transmission wherein the shift transmission can be shifted by hand or can likewise be automated. The clutch can be a pull-type clutch or in another embodiment advantageously a push-type clutch. The clutch can also be a clutch with wear compensation or wear adjustment and
15 disengagement force reduction. These clutches adjust the working point during the course of the service life so that the wear which occurs is compensated and thus the required forces when operating the clutch are substantially the same or change only slightly throughout
20 the service life of the clutch.

A non-return valve 46 is integrated in the piston 30. The wall of the master cylinder 32 has a shifting bore 47 which is connected to a supply container 48 for hydraulic
25 fluid. To relax and/or support the electric motor 20 with regard to the operating forces of the clutch 44 such as the clutch resetting spring, a relaxation or compensation spring 49 is provided in the actor 18.

30 Figure 2 shows in a block circuit diagram the control of the electric motor 20. The electric motor 20 is connected through an end phase 50 to a control device 52 which has a micro processor 54 with integrated work memory as well as a program memory 56 and input/output interfaces 58. The
35 control device has several inputs 60 to which are

connected the sensors 33 and 34 as well as further sensors.

5 A part of the electronics of the control device can be formed as a position regulator which regulates the predetermined position of the clutch operation. This position regulator can in another embodiment be implemented in the control program for controlling the clutch operation.

10 To regulate or control the position of the output element of the actor such as of the master cylinder piston a position regulator is implemented inside the control device 52. This position regulator is formed as hardware 15 or preferably as software and controls or regulates the engagement position of the clutch.

20 Figure 3 shows an embodiment of the sensor 34. A pole wheel 64 is connected rotationally secured to the drive shaft 62 of the electric motor 20 and has along its outer circumference magnetic poles of alternate polarity. These magnetic poles are moved past a coil element 66 which supplies at its terminals 68 a voltage impulse each time a pole is moved past same.

25 Figure 3a shows a further embodiment of a position sensor 214 which is mounted inside the actor 213. The actor consists substantially of the drive motor, such as electric motor 212, the worm gearwheel 222, the thrust 30 crank 224, the master cylinder piston 225 and the master cylinder 211. The electric motor 212 drives a worm (not shown) which meshes with and drives the worm gearwheel 222. The crank rod 224 is attached to a stud on the worm gearwheel 222. Through rotation of the worm gearwheel 222 35 the crank rod is moved axially and thus moves the master cylinder piston. Furthermore an energy accumulator 226

such as a spring is mounted inside the master cylinder to support the electric motor 212. The master cylinder furthermore has a connection 250 with an opening 251 to a fluid reservoir. The sensor 214 has a movable element 5 214a which is connected through a stud to the gearwheel 222 so that the element 214a is axially displaced during movement of the gearwheel. An element is thereby displaced in a dip coil 214b and a signal is generated which corresponds to the position of the element 214a.

10

Figure 4 shows diagrammatically the switching of an end phase 50 for controlling the electric motor 20. Four transistors 70, 72, 74 and 76 are connected in a bridging circuit to the electric motor 20 so that the electric 15 motor 20 depending on the switching state of the transistors controlled by the control device 52 lies in one or other direction at the voltage source 78 or the electric motor is separated from the voltage source. Thus both the rotary direction and also, through the pulse 20 width modulation of the voltage impulse supplied to the electric motor 20, the voltage supply of the electric motor 20 can be controlled by the control device 52. The current and its through flow direction through the electric motor 20 can be measured by means of a current 25 measuring resistance 80.

30

The construction of the described component parts and their interaction is known and will therefore not be described in further detail.

For the operating security of the automated clutch of the construction described it is necessary to be able to detect easily and reliably the most varied of faults on the dashboard of a vehicle or with diagnosis at a 35 customer service workshop.

The simultaneous evaluation of the PWM signal controlling the electric motor 20 and the path measurement taking place by means of the sensor 34 permits conclusions on the moment sent out by the electric motor 20 and therefore 5 represents one possibility of detecting overload. Furthermore through this signal evaluation it is possible to detect the clutch stop whereby the control can react where applicable before a disconnection of the electric motor 20 as a result of overload.

10 The electric motor 20 which is formed as a direct current motor usually has a moment characteristic line which drops linearly with the speed, as shown in Figure 5 through the continuously marked straight line which represents the 15 maximum power (100 % PWM) of the electric motor at a temperature T_1 . If the pulse width is reduced, such as for example halved (50% PWM) then the continuously marked straight line is moved substantially with the same ratio to the dotted straight lines parallel towards lower power 20 outputs since the reduction of the pulse width also means a reduction in the effective voltage.

The connection between the PWM signal and the effective voltage U_{eff} is in a first approximation substantially 25 linear.

With a change in temperature the gradient of the straight lines changes, as shown by the chain-dotted straight line which shows the dependence of the speed n on the output 30 moment M with 100% pulse width and a temperature T_2 which is higher than the temperature T_1 .

The speed n can be derived directly from the signal of the sensor 34. The pulse width of the PWM signal can be 35 determined in the control device 52. The temperature of the electric motor 20 is detected by means of the sensor

33. If a sensor 33 is not present then the temperature of the electric motor can be calculated by means of a mathematical model which is implemented inside the control device. The temperature thus lies within the control device as a data batch.

5 Figure 6 shows a diagram in which the current I of the electric motor is recorded over the torque moment M . The curve 101 and the curve 102 represent current curves as a function of the torque which are recorded in the case of different temperatures T_1 and T_2 . The curve 101 is recorded at a higher temperature T_2 than the curve 102 at the temperature T_1 . The curves current as a function of the torque thus change as a function of the temperature.

10 15 Figure 7 shows a diagram in which the load moment M_{last} of the electric motor or of the drive of the automatically operable clutch is shown as a function of the operating path. The operating path is thereby shown as an armature angle φ_{Anker} whereby the operating path could also be shown in millimetres. The armature angle is only a representative variation whereby a calculation factor lies between the angle and the path. The curve 110 shows the path for an actor without compensation and the curve 111 shows a path with compensation. The compensation is carried out in the example through an energy accumulator which is arranged to support the electric motor at least in a partial area of the operating path. Through the action of the compensation spring the characteristic line 20 25 30 of the path 111 is displaced in the direction of the y-axis and a distribution of the load M_{last} of the motor takes place so that this pulls in a partial area and pushes in another partial area whereby the torque level is however reduced overall.

Figure 8 shows a block circuit diagram 300 in which the blocks of the clutch control 301, the position regulator 302, the memory 303, the fault detection 304 and the electric motor 305 are shown. The blocks 301 to 304 can 5 be implemented inside the control device or can be implemented as individual groups. The control 301, the position regulator 302 as well as the fault detection 304 can each be formed as hardware or software within the control device. The memory takes place in an E²PROM. The 10 electric motor 305 operates the clutch automatically for example through a gearbox (not shown) on the output side.

The clutch control 301 receives a series of input signals 306 such as from sensors or other electronic units, such 15 as for example from the engine management system, an ABS control unit and/or other units. The clutch control 301 calculates from these data the clutch ideal position $K_{SOLLPOS}$ (307) which is passed on through the output to the position regulator 302 and to the fault recognition 303. 20 The position regulator 302 is constructed as a PID regulator or another regulator. The position regulator controls or regulates from the clutch ideal position $K_{SOLLPOS}$ and from the clutch actual position K_{ISTPOS} which it obtains through a sensor, the clutch position or the torque 25 transferable by the clutch. The actual position is regulated to the predetermined position through the regulating deviation between the ideal position and actual position.

30 As input signal is for example at least one of the following signals: engine speed, gearbox speed, accelerator pedal position, throttle valve position, gear lever position, gear gate position, engine moment, transferable clutch moment, clutch engagement position 35 etc.

The clutch ideal position k_{istpos} is determined by a sensor which determines the actual clutch engagement position K_{ist} . This sensor is integrated in Figure 8 in the block of the engine so that the value K_{istpos} (309) adjoins the 5 output of the engine block 305 and is passed onto the position regulator and the fault detection 303.

The position regulator 302 receives the ideal signal and the actual signal and thus forms a control signal 308 by 10 means of which the engine is controlled in order to carry out the opération according to the ideal value. The engine operates the clutch which is indicated by the arrow 309. The position regulator sends out for example a PWM signal for controlling the engine. Furthermore the 15 position regulator can issue a direction of the operation so that the correct operating direction is controlled.

The control signal 308 is likewise passed on through the signal 308a to the fault detection 303. The fault 20 detection compares for example the ideal value with the actual value and determines an error. The fault signal 310 is passed on to both the control unit and to the fault memory 304 and is stored there non-fleetingly. The clutch control can control from the presence of the fault signal 25 an emergency running strategy. Storage in a non-fleeting memory has the advantage that with a later retrieval of the fault memory it can be detected which fault occurred for example when (if the time point of the presence of the fault is stored as well).

30

By way of example it is pointed out that despite supplying current to the actor on reaching a fixed stop the ideal value and actual value do not coincide since as a result of the stop the actual value is unchanged and a difference 35 with the ideal value is maintained.

Examples of faulty functions will now be explained which can be readily determined by evaluating the said measured signals and comparing the signals with ideal values using algorithms laid down in the program memory 56:

5

- 1) Overload with a bent lead 35 or jamming piston 30 or 38 or similar.

10 With the aforementioned faults the electric motor 20 must apply a large force in order to each the required displacement of the piston 30. The pulse width of the PWM signal is thereby very great without the electric motor 20 reaching its normal speed. The design of the actor 18 is
15 such that it normally develops three times the force than is necessary for operating the clutch. If the pulse width permanently exceeds a threshold value of for example 66% and the speed of the electric motor 20 thereby lies permanently below a threshold value of for example 33% of
20 the possible speed then this signifies a load which is considerably above the normal case and which is evaluated as a fault indication which is indicated by a display unit connected to the control device 52 which can be in the dashboard of the vehicle or can be contained in a
25 diagnosis appliance (not shown) which can be connected to the control device 52.

As well as reaching a threshold value it is also possible to detect a deviation of a value from a previously stored
30 reference path and to store it as significant deviations.

It is evident that very low outside temperatures can lead to increased setting forces owing to the high viscosity of the hydraulic fluid so that this case is advantageously
35 excluded for diagnosis.

Consequential faults of the faulty functions mentioned above are for example too high a setting temperature, faults in the association of the position of the piston 30 with the position of the operating member 42 (as a result 5 of untight areas) as well as a cut-out of the electric motor 20 as a result of overload.

2) Heavy-going transmission within the actor 18:

10 Even in this case the electric motor 20 is severely stressed above average in operation. The fault can be detected in the case of workshop diagnosis in that with a clamped-down piston rod 28 when the thrust rod 26 moves back against the force of the compensation spring 45 a PWM 15 signal is produced which lies above an ideal value. This faulty function can also lead in normal operation to increased temperature in the electric motor 20 and thus to a warning display or even to an automatic cut-out of the electric motor 20.

20

3) Clutch stop:

When the clutch moves too early, i.e. with too small a displacement of the piston 30 to the right against its 25 fully opened stop this likewise indicates a faulty function, for example in that the hydraulic volume has increased between the pistons 30 and 38 through after-suction or too high a temperature or however as a result of too long a shifting pause. The pulse width of the PWM 30 signal can in this case increase unacceptably sharply prior to reaching an ideal position (detected through evaluation of the signal of the sensor 34), which is recognised in the control device 52 and leads to a corresponding indication.

35

Additionally as indicator for reaching the stop it can be evaluated that the clutch 44 transfers no or only very little moment when the plate spring tongues reach the stop. The case of the clutch stop and poorly separating 5 clutch can occur in the event of a very powerful energy input into the clutch and consequently the plate spring tongues wandering in the stop direction.

3a) Clutch stop:

10

Another possibility of diagnosing a faulty clutch stop is as follows:

15 If an ideal clutch position (for example through the provision of an ideal path on the sensor or the impulse speed of the sensor 34) cannot be reached and the clutch previously moves against a stop then with a high pulse width and a stationary state or a slow movement which is detected by means of a sensor 34, after a predetermined 20 time length a warning signal is produced in order to be able to resort to measures through the control. At the end of a further predetermined time period the electric motor 20 is switched off to protect against overload.

25 3b) Stop recognition during driving operation:

With certain clutch designs, more particularly self-adjusting clutches the stop position is moved according to the wear on the linings. If the ideal position of the 30 stop position is not corrected accordingly this leads to a faulty function since the ideal stop cannot be reached but the clutch moves previously to the stop. This stop is detected in that the electric motor 20 turns no more despite a large pulse width of the PWM signal. If this 35 state is maintained over a predetermined time length then a warning bit can be set (actor cannot regulate the ideal

path). In addition or instead of the warning bit the ideal value target for the stop or the fully opened clutch position can be set to the actual system setting. This counteracts a cut-out of the electric motor 20 through 5 overload since by up-dating or adapting the ideal value the actual value reaches the ideal value which leads to a cut-out of the electric motor 20 on account of reaching the ideal position.

10 With maintenance work the ideal position adaptation can be input in a test apparatus or diagnosis appliance and is available for checking the clutch. Thus a stop detection can be carried out in a test mode. The test mode can be activated by a special switch of the control device and 15 does not serve for the normal control of the automated clutch in the driving operation of the vehicle.

For diagnosis purposes a program part can be activated in 20 the control device 22 by means of a test apparatus whereby this program part moves the ideal path of the piston 30 of the master cylinder 32 out further from the position 'clutch open' (the clutch is opened even further). As soon as the overload warning is produced the actual path 25 reached is stored by this program part and the ideal path withdrawn so that there is no longer any danger of an overload. The actual path thus detected or a value derived therefrom (e.g. the result of a comparison with a threshold or an instruction for clutch exchange) is issued by the program part to the test or diagnosis apparatus.

30 4) Broken compensation spring 49:

This fault function is detectable through an unusually high strain on the electric motor 20 during opening of the 35 clutch (movement of the piston 30 to the right) or through an unusually low strain on the electric motor 20 on moving

back into the closed state of the clutch. A sequential fault here is also that the temperature of the electric motor 20 can be too high in operation which can lead to an automatic cut-out of the electric motor 20.

5

The said fault functions can be detected on board by corresponding programs or algorithms recorded in the program memory 56 of the control device 52 or within the scope of a workshop diagnosis by means of a diagnosis 10 appliance connected to the control device 52.

5) Diagnosis of fault functions by means of mean value signals:

15 By forming the mean value of the signals of the current it is in principle possible to derive a continuous force signal. The mean value of the current can either be measured in the control device or derived or calculated from the pulse width ratio of the current supply circuit, 20 the actual voltage of the battery 78 and the resistance R of the electric motor 20 which is a known function of its temperature. With the continuous signal the clutch stop and the path-force-characteristic line of the clutch can be measured and compared with an ideal path force 25 characteristic line. The diagnosis possibilities are expanded to the following situation example or deviations of the ideal from the actual characteristic line:

- Stop in the event of lift : clutch worn or defective
- 30 - Stop below lift : hydraulic section blocked
- Too little pressure : section with air, i.e. clutch is not opened
- No pressure : component part break, section with leak, no/defective clutch
- 35 - Too much pressure : wrong clutch, no self-adjustment.

The invention is not restricted to the use of pulse-width-modulated electric motors in the actor. It can also be used where it is not directly a question of measuring the 5 pulse width, for other types of control for electric motors or hydraulic actors.

With a method for detecting fault functions of a clutch operated by means of an electric motor, more particularly 10 in the drive train of a motor vehicle wherein the electric motor is controlled by means of a PWM signal, the pulse width of the PWM signal is measured and the position and/or speed of a component part operated by the electric motor is determined. The measured pulse width and/or 15 position and/or speed of the component part is compared with ideal values. With a deviation between the ideal values and measured values which exceeds predetermined values a fault signal is produced. With a further method the time length is measured which is required by an actor 20 to operate the clutch to move a component part into an ideal position and a fault signal is produced when this time period exceeds a predetermined value. With a further method the position of the moved component part is detected continuously and an end position deviating from 25 the ideal position is fixed as the new ideal position when the end position is maintained longer than a predetermined time length.

The patent claims filed with the application are proposed 30 wordings without prejudice for obtaining wider patent protection. The applicant retains the right to claim further features disclosed up until now only in the description and/or drawings.

35 References used in the sub-claims refer to further designs of the subject of the main claim through the features of

each relevant sub-claim; they are not to be regarded as dispensing with obtaining an independent subject protection for the features of the sub-claims referred to.

5 The subjects of these sub-claims however also form independent inventions which have a design independent of the subjects of the preceding claims.

10 The invention is also not restricted to the embodiments of the description. Rather numerous amendments and modifications are possible within the scope of the invention, particularly those variations, elements and combinations and/or materials which are inventive for example through combination or modification of individual 15 features or elements or process steps contained in the drawings and described in connection with the general description and embodiments and claims and which through combinable features lead to a new subject or to new process steps or sequence of process steps insofar as 20 these refer to manufacturing, test and work processes.

CLAIMS

1. Method for detecting faulty functions of a clutch
5 operated by means of a drive, more particularly in the drive train of a motor vehicle wherein the drive is controlled by means of a control signal, in which method the pulse width of the control signal is detected or measured and the position and/or speed of a component part
10 operated by the drive is determined.
2. Method for detecting faulty functions of a clutch
15 operated by means of a drive, more particularly in the drive train of a motor vehicle wherein the drive is controlled by means of a control signal, with which method a value such as the pulse width of the control signal is detected or measured, the position and/or the speed of a component part operated by the drive is determined, the measured value, such as the pulse width and/or the
20 position and/or speed of the component part is compared with ideal values and when a deviation between the ideal values and measured values exceeds predetermined values a fault signal is produced.
- 25 3. Method for detecting faulty functions of a clutch
operated by means of an electric motor, more particularly in the drive train of a motor vehicle wherein the electric motor is controlled by means of a PWM signal, with which method the pulse width of the PWM signal is measured, the
30 position and/or speed of a component part operated by the electric motor is determined, the measured pulse width and/or position and/or speed of the component part is compared with ideal values and in the event of a deviation between the ideal values and measured values which exceeds
35 predetermined values a fault signal is produced.

4. Method according to one of the preceding claims 1 to 3 wherein an ideal position of the component part (64) is started with regulation of the PWM signal, the pulse width of the PWM signal is measured and compared with an ideal value and when a predetermined deviation is exceeded a fault signal is produced.

5. Method according to claim 4 characterised in that the deviation is the amount of the difference between the 10 ideal value and measured value (actual value).

6. Method according to one of claims 3 to 5 wherein a position reached before reaching the ideal position and at which the pulse width of the PWM signal increases sharply 15 is fixed as the new ideal position.

7. Method according to one of claims 1 to 6 wherein at least the ideal value of the PWM signal depends on the 20 temperature of the drive, such as electric motor and the temperature is measured or calculated by means of a sensor.

8. Method for detecting faulty functions of a clutch operated by means of an actor, more particularly in the 25 drive train of a motor vehicle wherein the actor is regulated so that a component part moved by same reaches predetermined ideal positions, with which method the time length which the actor requires to move the component part 30 into an ideal position is measured and a fault signal is produced when this time length exceeds a predetermined value.

9. Method for detecting faulty functions of a clutch operated by means of an actor, more particularly in the 35 drive train of a motor vehicle wherein the actor is regulated so that a component part moved by same reaches a

predetermined ideal position, with which method the position of the moved component part is continuously detected and an end position deviating from the ideal position is fixed as the new ideal position when this end 5 position is maintained longer than a predetermined time length.

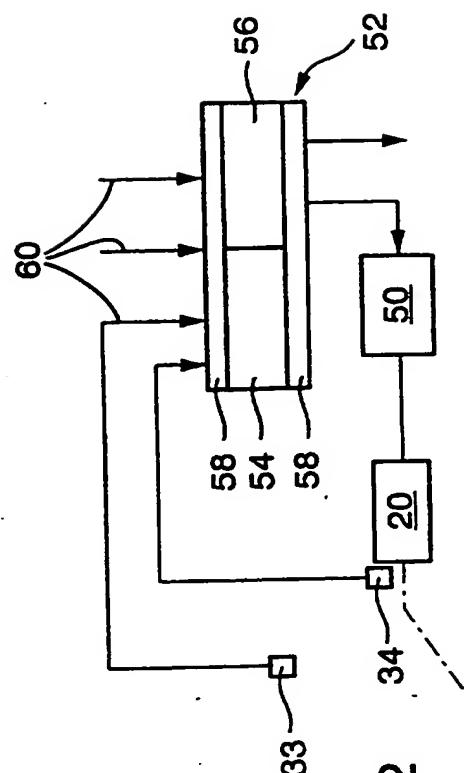
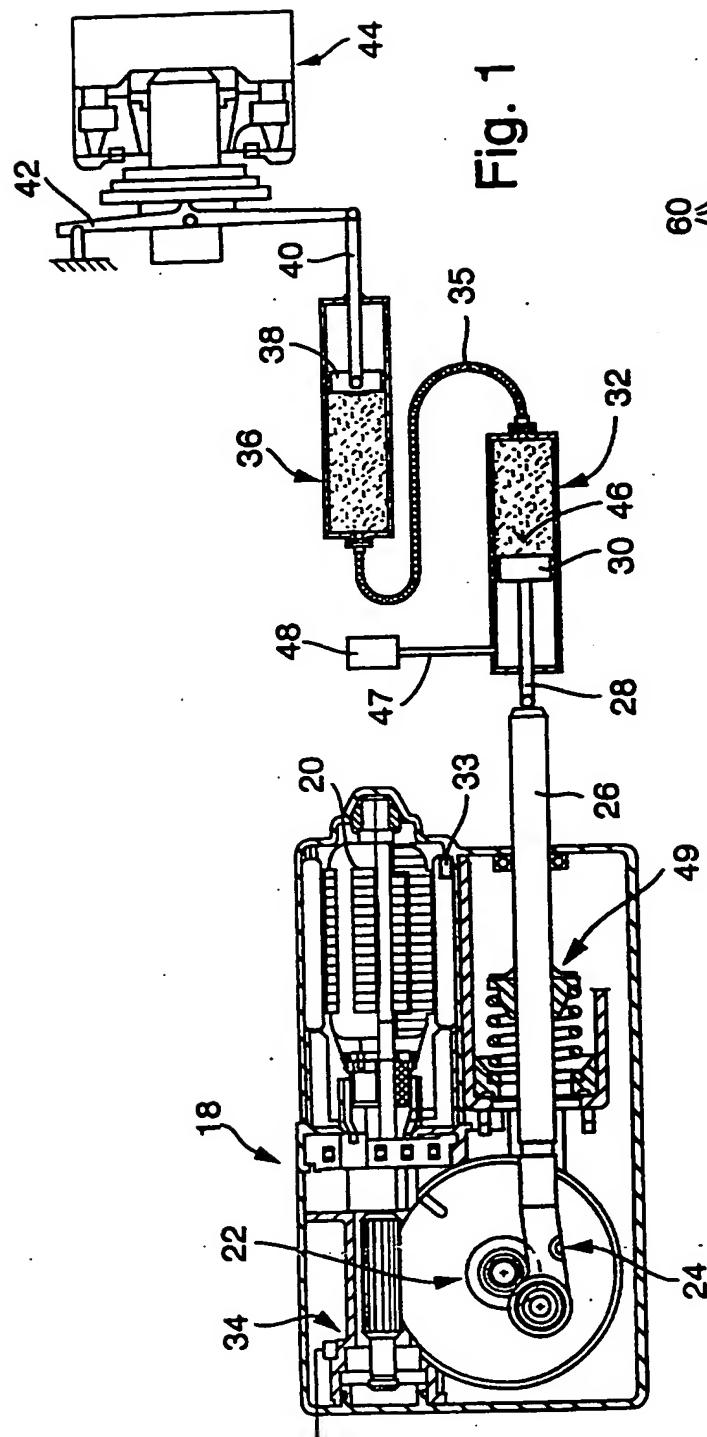
10. Method according to one of claims 1 to 9 wherein the voltage or voltage source is measured for the electric 10 motor or actor and is taken into account when calculating voltage-influence values.

11. Method according to one of the preceding claims characterised in that an ideal control signal preset or 15 determined by a control unit is the detected control signal.

12. Apparatus for carrying out the method according to any one of claims 1 to 3, 5 or 6, the apparatus comprising 20 a clutch, an actor for operating the clutch, at least one sensor for detecting the position of a component part operated by the actor, a control apparatus with micro processor and a memory device which controls the actor according to programs filed in the memory device and in 25 the event of deviation of the sensor signals and/or the power supplied to the actor from ideal values produces a fault signal.

13. A method for detecting faulty functions of a clutch 30 operated by means of a drive substantially as herein described with reference to the accompanying drawings.

14. Apparatus for detecting faulty functions of a clutch operated by means of a drive substantially as herein 35 described with reference to the accompanying drawings.



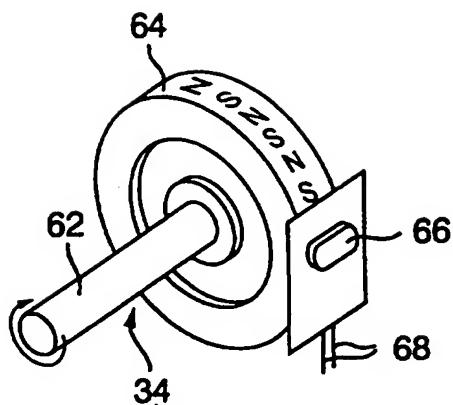


Fig. 3

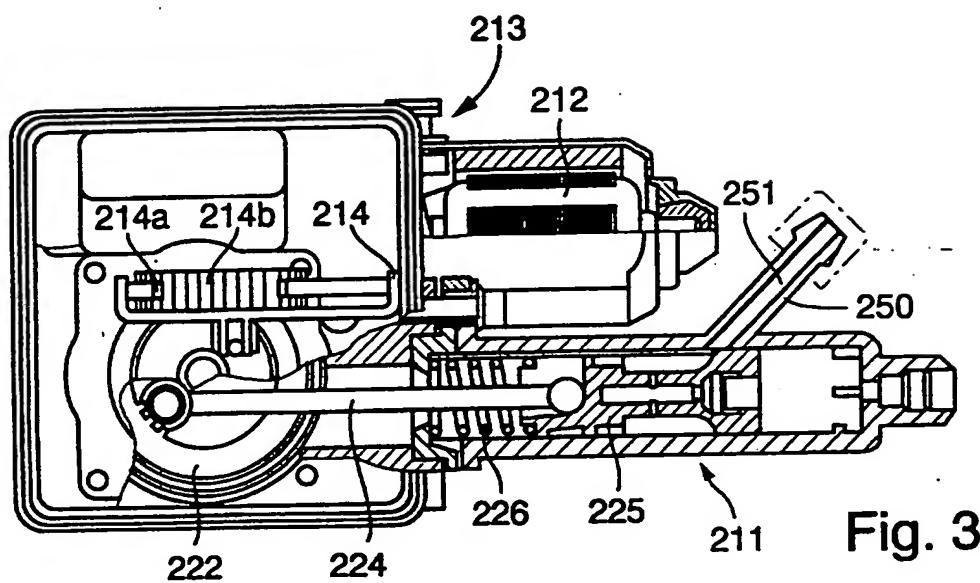


Fig. 3a

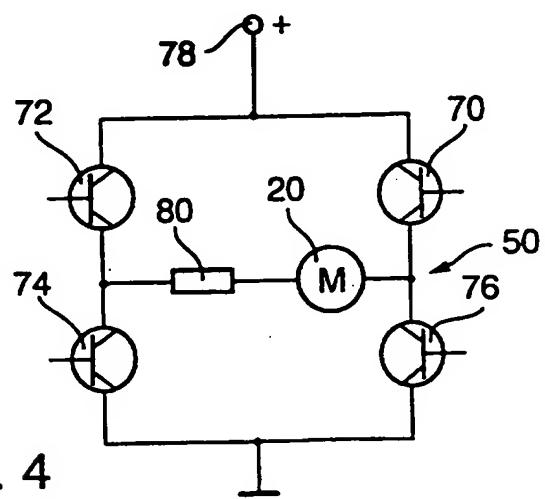


Fig. 4

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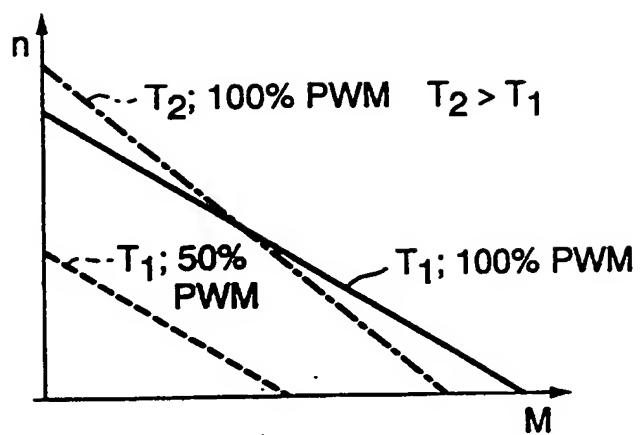


Fig. 5

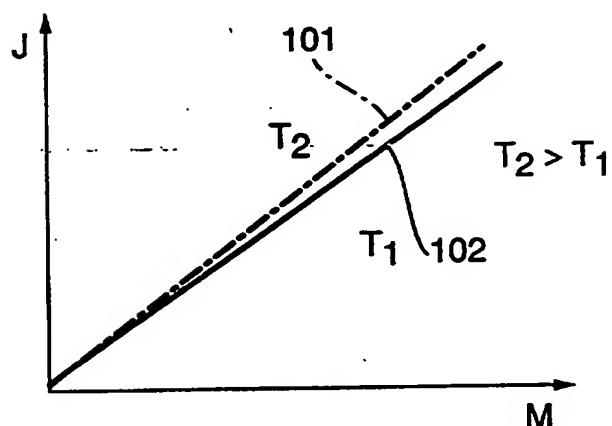


Fig. 6

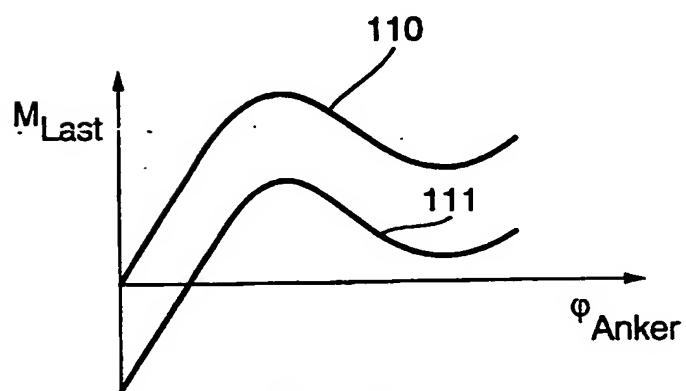


Fig. 7

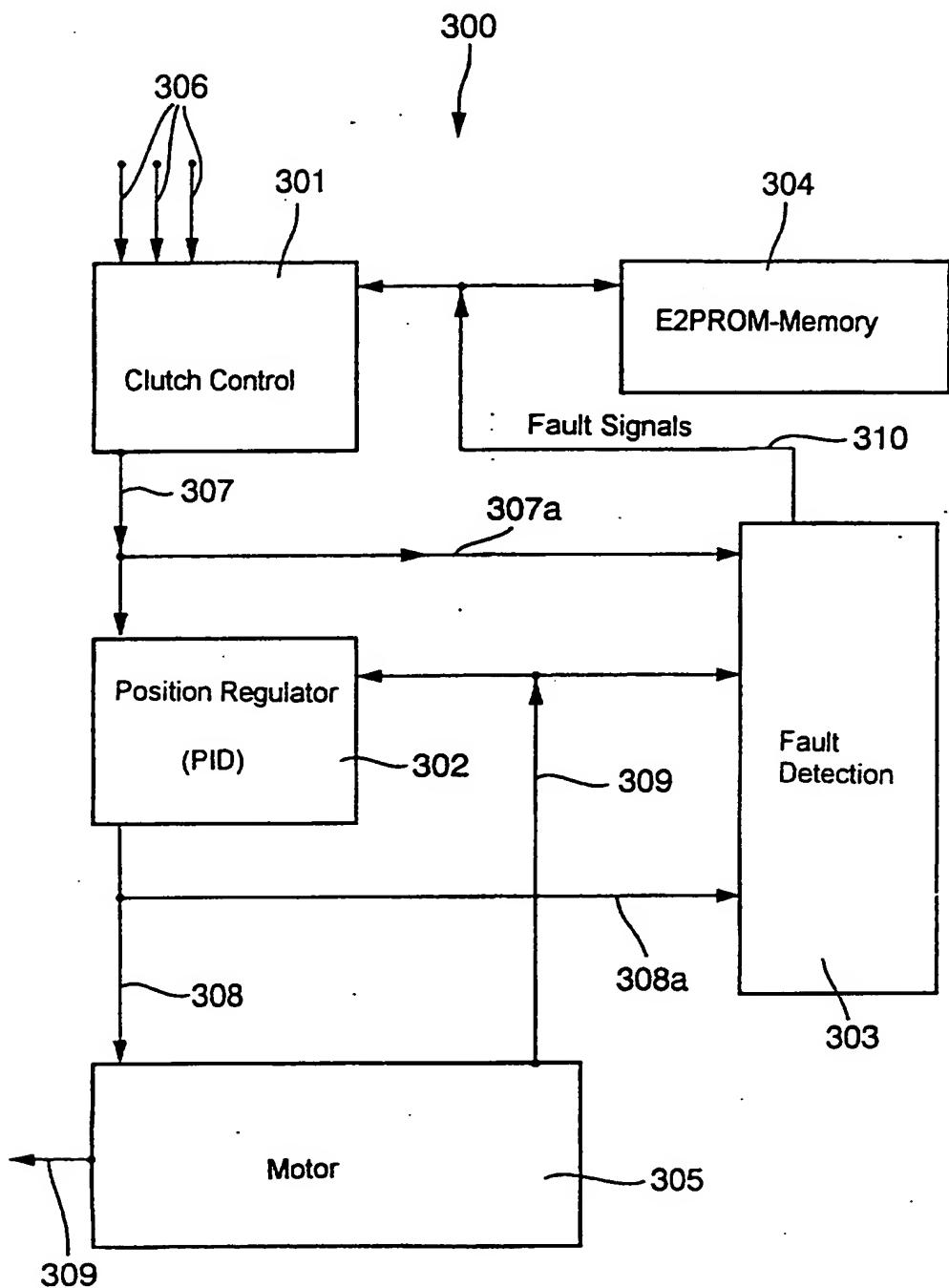


Fig. 8